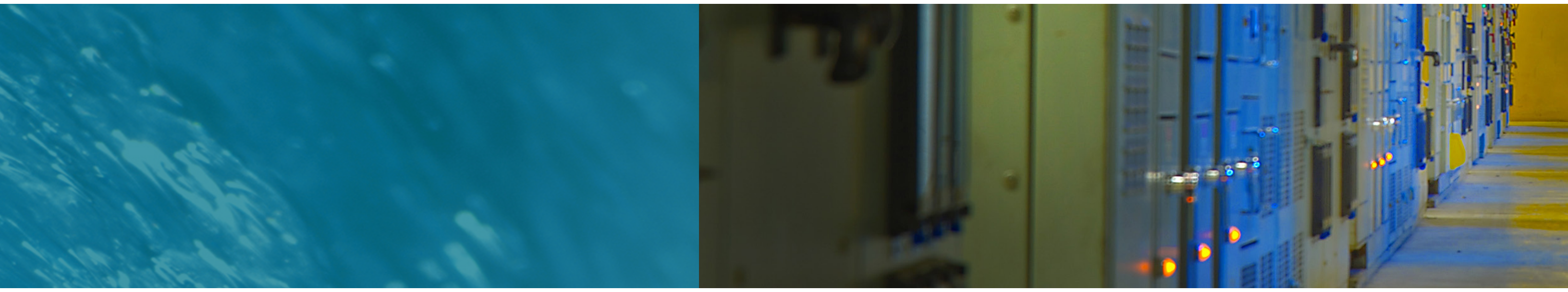
VOLUME 3 - RESOURCE MANAGEMENT STRATEGIES

CHAPTER 7

System Reoperation



Kern County. The Edmonston Pumping Plant, as the highest lift pumping facility in the State Water Project (SWP), plays a vital role in nearly all system reoperation projects involving the SWP. The plant's huge motor-pumping units lift water nearly 2,000 feet up and over the Tehachapi Mountains through 10 miles of tunnels.

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Chapter 7. System Reoperation

Introduction

System reoperation in the context of water resources means changing existing operation and management procedures for a water resources system consisting of supply and conveyance facilities and end user demands with the goal of increasing desired benefits from the system. System reoperation may seek to improve existing water facilities to meet existing system needs more efficiently and reliably, or it may seek to prioritize one system need over another. Although reoperation of existing facilities is generally regarded as the preferred alternative to constructing major new facilities, minor physical modifications to existing facilities may be necessary to eliminate constraints to reoperation and to meet operational goals. Changes to the water rights or regulatory framework for allocating water — for example, modifying existing water rights or creating new supply exchange agreements — may also be required.

Some systems may be very simple and include only a single surface water reservoir or groundwater basin. Other water systems may be much more complex, consisting of many facilities that form a combination of local, interregional, and interstate water sources and delivery destinations. The concept “system reoperation” applies to the system at all scales, thus reoperation can be implemented at different scales within a system, ranging from individual facilities to several integrated components.

Reoperation of existing facilities usually serves three basic purposes:

1. Addresses a specific problem(s) and/or need(s).
2. Improves efficiencies.
3. Adapts facilities to anticipated future changes (changes in water demands, legal and regulatory constraints, and key physical variables such as climate).

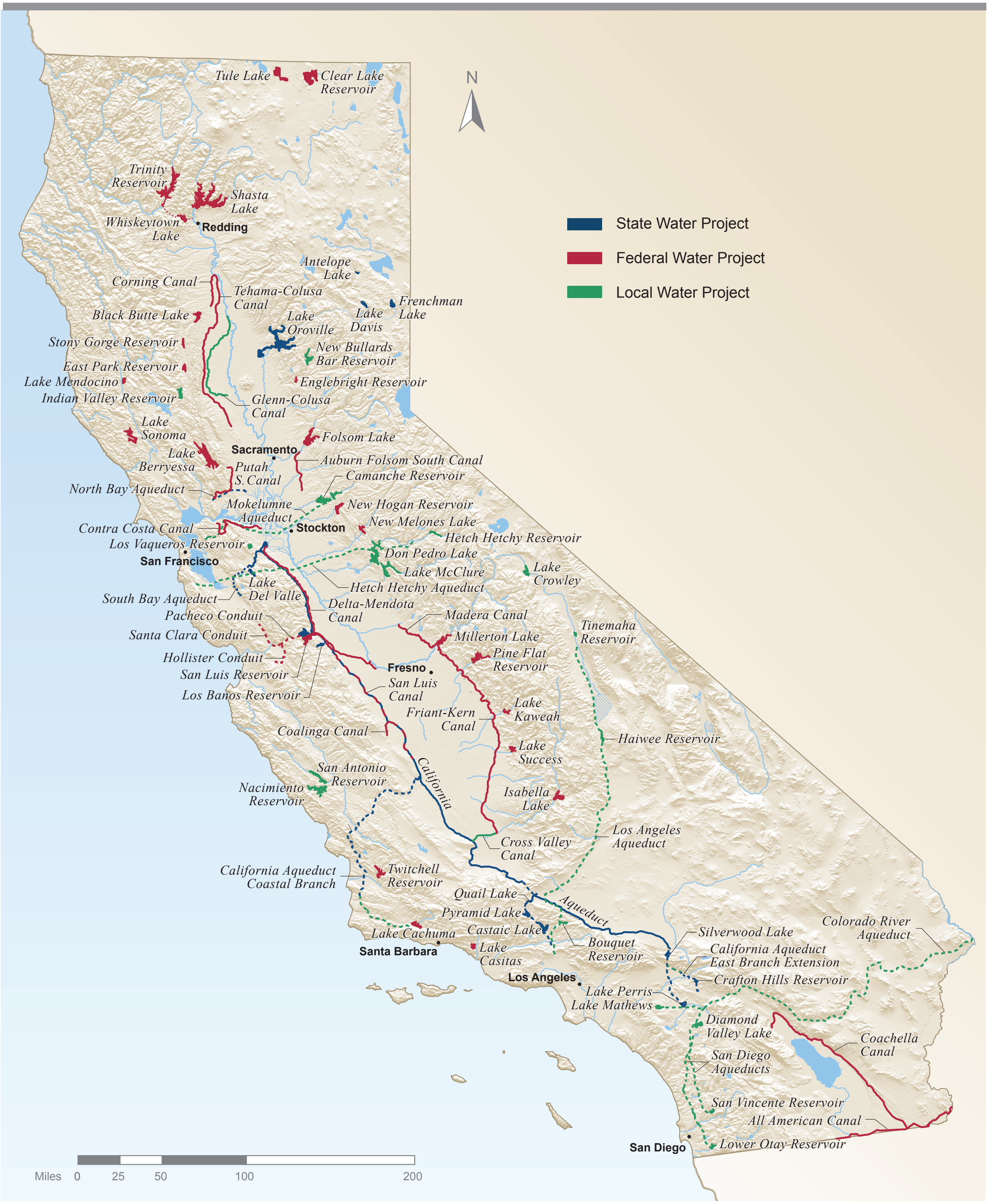
Background

California’s statewide water system is comprised of a diverse set of local, State, and federal projects, as depicted in Figure 7-1. These projects include facilities such as dams and reservoirs, hydropower plants, canals, and water diversion structures. Many of these facilities were developed in the 20th century, and were not designed, constructed, or operated as an integrated water supply and flood management system. Over time, operations of the two largest projects, the State Water Project (SWP), operated by the State, and the Central Valley Project (CVP), operated by the federal government, have been integrated to a certain degree. The current level of integration is based on the Coordinated Operating Agreement that was initiated in the 1970s and finalized in 1986.

California’s water supply and flood control systems are inextricably linked, from Trinity County in the north to Imperial County in the south, through physical interconnections and coordinated management arrangements. This reality influences water resources planning in two ways:

1. Changes in water management at any point may have consequences throughout the rest of the system.

Figure 7-1 Location of Local, State, and Federal Water Projects



2. The inherent physical interconnections in the system provide opportunities for improving water resource benefits throughout the state via systemwide optimization.

DWR's System Reoperation Study (SRS) was undertaken with these two points in mind. In recognition of these points, this SRS represents a systems analysis to understand how changes influence the system and in what ways the system can be optimized to meet reoperation goals. Current water resources problems necessitate better integration and optimization of the State's flood protection and water supply management system.

Study Authorization

The authorization and funding of the SRS were granted by the Legislature through Senate Bill X2 1 (SB X2 1) (chapter 1, statutes of 2008 – California Water Code Section 83002.5), which mandated and allocated resources for "planning and feasibility studies to identify potential options for the reoperation of the state's flood protection and water supply systems that will optimize the use of existing facilities and groundwater storage capacity." Specifically, SB X2 1 stipulated that "the studies shall incorporate appropriate climate change strategies and be designed to determine the potential to achieve the following objectives:

> (I) Integration of flood protection and water supply systems to increase water supply reliability and flood protection, improve water quality, and provide for ecosystem protection and restoration.
>
> (II) Reoperation of existing reservoirs, flood facilities, and other water facilities in conjunction with groundwater storage to improve water supply reliability, flood hazard reduction, and ecosystem protection and to reduce groundwater overdraft.
>
> (III) Promotion of more effective groundwater management and protection and greater integration of groundwater and surface water resource uses.
>
> (IV) Improvement of existing water conveyance systems to increase water supply reliability, improve water quality, expand flood protection, and protect and restore ecosystems."

To meet the legislative objectives, DWR, in coordination with willing participants, is conducting studies to identify and evaluate potential operations strategies for reoperation of the State's flood protection and water supply systems. These reoperations strategies will be assessed with respect to their ability to improve (1) water supply reliability, (2) flood hazard reduction, and (3) ecosystem protection and restoration.

Along with the three objectives, water quality, groundwater overdraft, and climate change are also mentioned in SB X2 1. Water quality affects water supply and ecosystems, and therefore is included in those discussions. Similarly, groundwater overdraft is considered as a component of water supply. Finally, because climate change increases the variability of hydrology and because such variability is expected to further stress future water supply, flood hazard management infrastructure, and aquatic ecosystems, climate change is part of each of those topical areas.

Geographic Scope

The geographic scope of this study could include the entire state; however, a close read of the authorizing language indicates a focus on systems and systemwide analyses. The legislative mandate focuses this study on the “State’s flood protection and water supply systems.” This suggests that emphasis should be given to those areas of the state where both of these systems are found. Much of the State’s flood control infrastructure is located in the Central Valley and the Central Valley is also where the greatest concentration of interconnected water supply infrastructure is located. Additionally, a significant percentage of California’s water supply originates in the northern Central Valley. Because this infrastructure has had a profound effect on aquatic ecosystems, the greatest potential for ecosystem restoration through infrastructure reoperation is also found in the Central Valley. For these reasons, the initial geographic scope for identifying system reoperation will be limited to the Central Valley.

DWR recognizes that there are several independent watersheds that contain a certain level of systemized infrastructure development. Ownership of these systems varies and opportunities for reoperation and optimization may exist provided cooperation from the owners and operators can be obtained. However, the initial focus for system reoperation is in the Central Valley due to the integration, size, and proximity of existing infrastructure, and the perceived opportunities for meeting the stated goals of the authorizing legislation. Figure 7-2 shows the location of the Central Valley and study area for the SRS.

Study Phases

Five phases were identified in the System Reoperation Plan of Study (June 2011) for carrying out the study. The primary purpose of the Plan of Study was to define the phases of the study such that it can be used as a guide to implement each phase. The study phases have been modified and updated since the Plan of Study was completed. The current study phases are described below.

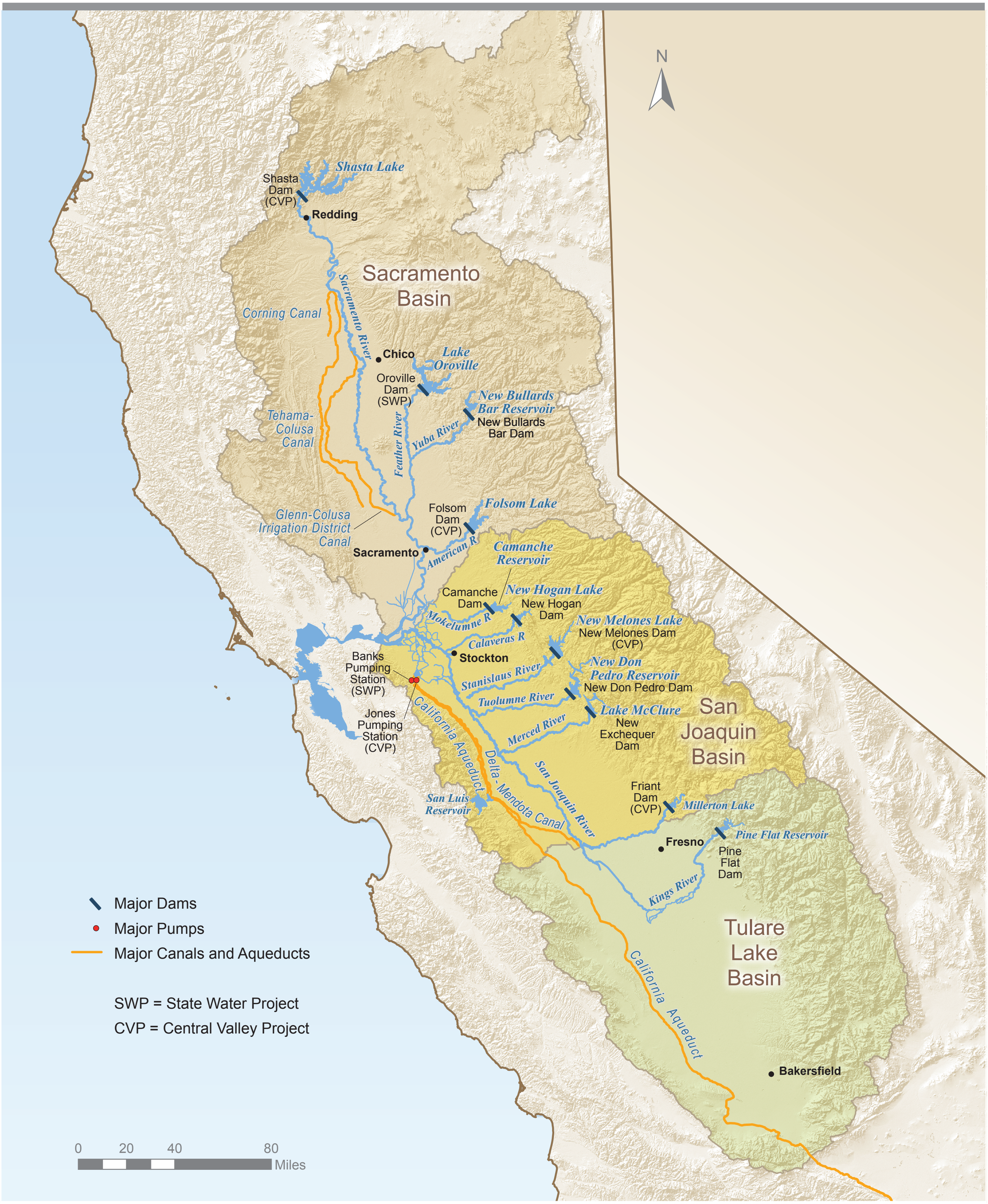
Phase 1: Preliminary Reoperation Measures and Concepts

In Phase 1, the relevant existing literature, related programs, and available tools were assessed for use in subsequent phases. The planning process to formulate preliminary reoperation strategies was established and followed. This phase is important in that it established the ground rules for developing the SRS and identified preliminary reoperation measures and concepts.

Phase 2: Strategy Formulation and Refinement

In Phase 2, the preliminary reoperation measures and concepts identified from Phase 1 was refined and formulated into potential reoperation strategies. Phase 2 included input and identification of fatal flaws from technical experts, affected parties, as well as outreach and coordination with other relevant programs. Phase 2 yielded specific potential reoperation strategies determined to warrant continued consideration.

Figure 7-2 Location of Central Valley and Study Area of System Reoperation Study



Phase 3: Preliminary Assessments of Strategies

Preliminary assessments will be conducted on those strategies carried forward from Phase 2. The purpose of the preliminary assessments will be to assess the strategies ability to meet the objectives of the study, and rank the reoperation strategies relative to one another. These preliminary assessments will provide a sound basis for selecting strategies that warrant reconnaissance level assessments in Phase 4.

Phase 4: Reconnaissance Level Assessments of Strategies

Strategies carried forward from Phase 3 will be subject to a reconnaissance level assessment. The reconnaissance level assessment will be performed at a more detailed level than the preliminary assessments and will rely upon existing tools (e.g., water supply, flood, and ecosystem related models). The purpose of the reconnaissance assessments will be to evaluate and determine whether or not the selected strategies warranted further evaluation for potential recommendation for implementation, develop a relative ranking of the reoperation strategies, and identify needed funding and key steps necessary for implementation.

Phase 5 was identified in the Plan of Study as the strategy implementation phase. Strategy implementation is beyond the scope of this study and is therefore not a part of the study.

Planning Principles

In development of the SRS, DWR has adopted a set of guiding principles:

- Water supply benefits resulting from reoperation will be shared with the owners of the projects as negotiated with the owners.
- Reoperation studies of regional and local projects will be performed with the collaborative and voluntary participation of the facilities owners and operators.
- Priority for study will be reoperation opportunities that simultaneously reduce flood hazards, improve water supply reliability, and restore damaged ecosystems.

Phase 1: Preliminary Reoperation Measures and Concepts

During Phase 1, management and physical reoperation measures were identified that addressed one or more of the objectives and capitalized on existing opportunities. Measures were formulated based on a review of available reoperation literature and suggestions from knowledgeable experts. Reoperation measures were combined with other measures to create reoperation scenarios resulting in greater benefits to the water system. A conjunctive use scenario, for example, might include construction of conveyance and recharge facilities, integration of two or more reservoir project operations, and reoperation at those same reservoirs. Thus, many individual measures are not complete by themselves, but must be combined with other measures.

The measures were formulated and organized based on the system reoperation building blocks identified in the Plan of Study. During measure formulation, measures were only identified under these building block categories:

- Integrate CVP, SWP, and other local projects.

- Reoperate reservoirs.
- Integrate management of groundwater and surface water.
- Facilitate water transfers.
- Change stream flow regime/patterns.
- Expand through valley conveyance/reactive floodplains.

The preliminary reoperation measures and concepts developed in Phase 1 are shown in Box 7-1. Phase 1 was completed in July 2011.

Phase 2: Reoperation Strategy Formulation and Refinement

In Phase 2, preliminary reoperation strategies were formulated based in part on the reoperation measures and concepts identified in Phase 1 and in part from inputs from cooperators. Those strategies were further developed and screened through a process of consultations with agency experts, facility owners and operators, and experts from within and outside of the study team. The reoperation strategy candidates were formulated based on the following criteria:

- Has the potential to provide net benefits that satisfy the three study objectives of (1) flood hazard reduction, (2) improvements in water supply reliability, and (3) restoration or enhancement of natural functions in river ecosystems.
- Can be accomplished with only minor capital improvements to the water system, which are limited to those that are necessary to reoperate existing infrastructure. The exception is the isolated Delta conveyance. All of the promising reoperation strategies that have a nexus to the Delta will be evaluated with and without an isolated Delta conveyance in Phase 3.

During the summer of 2012, the study team consulted with various water management institutions and organizations whose infrastructures or water management policies would be implicated in the reoperation strategies or that have expert knowledge of system reoperation. Through this vetting process, the study team obtained input and used the information to further refine some reoperation strategies and eliminate some other strategies. The organizations that the study team consulted with during the vetting process are shown in Box 7-2.

As a result of the vetting process, some of the preliminary reoperation strategies were eliminated from further consideration due to various reasons, including unwillingness of the facility owner(s) to participate in the study, lack of sufficient operational flexibility for reoperation, or lack of sufficient benefit from reoperation. The preliminary strategies that were eliminated from further consideration after the vetting process include:

- Reoperation of Friant Dam (Lake Millerton). According to the Friant Water Authority, Lake Millerton is already operated to carryover only dead storage in many, perhaps most, years. That means there is very little additional operation flexibility that would be exploited under the reservoir reoperation in conjunction with groundwater banking options.
- Reoperation of Folsom Reservoir. Folsom Reservoir, too, has limited operational flexibility under current demands and constraints. This conclusion is based on previous vetting with the CVP Folsom operations staff. It appears that the best way to incorporate Folsom Reservoir into a reoperation scenario may be in conjunction with Shasta Reservoir reoperation.
- Reoperation of New Don Pedro Reservoir. The co-operating irrigation districts, Turlock Irrigation District and Modesto Irrigation District, are going through a FERC (Federal Energy

Box 7-1 System Reoperation Measures and Concepts

Integrate Groundwater and Surface Water Operations

- Integrate operations of reservoirs in the American River watershed with groundwater pumping operations of groundwater authorities in the Sacramento area near the American River.
- Integrate operations of reservoirs in the Sacramento River watershed with groundwater pumping operations of the San Joaquin County groundwater users.
- Integrate operations of reservoirs in the Sacramento River watershed with groundwater pumping operations of the San Joaquin River of the Tulare basin groundwater users.
- Integrate reoperation and groundwater storage operations to facilitate Bay Delta Conservation Plan solutions.
- Integrate operations of reservoirs in the San Joaquin River watershed and groundwater pumping operations of the Merced District groundwater users using in lieu recharge.
- Integrate operations of reservoirs in the San Joaquin River watershed and groundwater pumping operations of the Madera District groundwater users using active recharge.
- Integrate operations of reservoirs in the San Joaquin River watershed and groundwater pumping operations of the Merced and Turlock Districts' groundwater users.

Integrate CVP, SWP, USACE, and Local Surface Water Operations

- Integrate CVP-SWP reservoir operations.
- Integrate operations of CVP, SWP, and South-of-Delta export pumps.
- Integrate operation of CVP reservoirs and USACE reservoirs.
- Integrate CVP-SWP reservoir operations and local reservoir operations.

Reactivate Floodplains for Improved Flood Hazard Reduction

- Reoperate flood control reservoirs in the Central Valley in conjunction with reactivated downstream floodplains.

Reduce Physical Losses of Water Supply through Transfer Facilitation

- Reduction in physical losses of water supply through transfer facilitation.

Capture Flood Control Spills and Store Them in Quarries

- Divert American River flood flows into existing sand and gravel quarries in the Mather Field/Jackson Highway/Florin Road area.

Improve Reservoir Operations Using Forecasting

- Implement forecast-based operations at CVP/SWP reservoirs in the Sacramento River watershed.
- Implement forecast-based operations at locally-owned reservoirs.
- Implement forecast-based operations in the Sacramento River watershed reservoirs.
- Implement forecast-based water quality operations at CVP/SWP reservoirs.
- Implement forecast-based water supply delivery releases at CVP/SWP reservoirs.
- Implement forecast-based operations at CVP reservoirs in the San Joaquin River watershed
- Implement forecast-based operations at locally-owned reservoirs in the San Joaquin River watershed.
- Implement forecast-based operations at CVP and locally-owned reservoirs in the San Joaquin River watershed.

Box 7-2 Organizations Consulted During Phase 2

Arvin-Edison Waters Storage District

California Water Plan – Stakeholder groups

Calleguas Municipal Water District

East Bay Municipal Utility District

Friant Water Authority

Glenn-Colusa Irrigation District

Inland Empire Utilities Agency

Kern Water Bank Authority

Madera Irrigation District

Merced Irrigation District

Metropolitan Water District

Modesto Irrigation District

NOAA Fisheries

North San Joaquin Water Conservation District

Orange County Water District

Raymond Basin Management Board

RD 108

San Gabriel Basin Water Quality Authority

Semitropic-Rosamond Water Bank Authority

SWP and CVP Operators:

The Nature Conservancy

Three Valleys Municipal Water District

Turlock Irrigation District

U.S. Army Corps of Engineers

U.S. Bureau of Reclamation

Regulatory Commission) relicensing process and do not wish to collaborate with DWR to study reoperation of New Don Pedro Reservoir.

- Reoperation of Camanche and Pardee reservoirs. According to East Bay Municipal Utility District, the Camanche and Pardee reservoirs are already operating efficiently and do not have potential operational flexibility for reoperation.
- Reactivating Floodplains for Improved Flood Management and Ecosystem Restoration. This stand-alone strategy does not appear to be able to achieve the three objectives of the study. Some type of reactivating floodplains or floodplain inundation concepts may be included in the remaining strategies that will be carried forward into Phase 3.

- Mechanisms to Facilitate Conservation Water Transfers. This strategy does not appear to be able to achieve the three objectives of the study. Also, no entities were interested in pursuing this strategy during the vetting process.
- Systemwide Reoperation Strategies to Implement the Solution Strategies of the Bay Delta Conservation Plan (BDCP). BDCP analyzed the operations of the existing water system with the new Delta conveyance. The new Delta conveyance associated with BDCP will be analyzed for all reoperation strategies that have a nexus to the Delta.

The remaining reoperation strategy candidates that emerged from the vetting process and will be carried forward into Phase 3 for preliminary assessments are:

- Reoperation of Shasta Reservoir.
- Reoperation of Oroville Reservoir.
- Reoperation of New Exchequer Dam (Lake McClure).
- Integration of the SWP and CVP operations.

Basic Concept of Reservoir Reoperation for Shasta and Oroville Reservoirs

The basic concept for the reoperation of Shasta and Oroville reservoirs is to lower carryover storage levels relative to current operations to increase flood reservation by conveying additional water to either an existing or future groundwater bank located in the Sacramento Valley or south of Delta with available capacity. This reoperation would reduce flood control spills and would occur at times when excess conveyance capacity is available in the Delta. To the extent reservoirs recover fully, the banked water is a supplement to water supplies. In dry years where complete storage recovery does not occur, the reservoir would be paid back with withdrawals from the groundwater bank and delivered to CVP/SWP customers on a full cost recovery basis.

Basic Concept for Reoperation of New Exchequer Dam

The concept for reoperation of New Exchequer Dam (Lake McClure) is with reservoir payback by in lieu groundwater banking within the Merced Irrigation District and the Merced Area Groundwater Planning Initiative (MAGPI). The reoperation would enable environmental flows to be restored from the dam to the Delta to improve conditions for steelhead trout. This strategy would be developed and conducted in partnership with Merced Irrigation District and MAGPI. The environmental flow release would have to be managed through the downstream infrastructure. Releases from Lake McClure pass through a series of power plants and smaller diversions and are regulated at McSwain Reservoir. Below McSwain Reservoir, water is diverted to Merced Irrigation District at the PG&E Merced Falls Dam and is diverted further downstream at Crocker-Huffman Diversion Dam. It is possible that the surplus water dedicated to steelhead habitat enhancement in the Merced River could be diverted below the confluence with the San Joaquin River for water supply.

Operational Components

Four operational components will be included in the reoperation strategies:

- Forecast-Based Operations. The goal is to reduce flood control space in reservoirs to allow higher storages at certain times of the year based on improved inflow forecasts.
- Conjunctive Management. Conjunctive management involves the coordinated use and management of groundwater and surface water resources to maximize the water supplies to meet water management objectives. Surface water and surface storage facilities need to be operated conjunctively with groundwater supplies and groundwater storage as a single system to maximize storage and water resources objectives. The goal is to develop more integrated management of groundwater and surface water supplies. Several different operational changes are possible with increased conjunctive management including increased groundwater banking through in lieu and active recharge and more aggressive reservoir reoperations backstopped by groundwater pumping.
- System Integration. The goal is to integrate operations between multiple reservoirs or increase the degree of integration at reservoirs that are currently integrated.
- Environmental Flows. A variety of new environmental flows may be included in each strategy. Differences in the timing and magnitude of environmental flows change how those flows can be used to meet multiple project objectives. Flows under consideration include floodplain inundation flows, spring pulse flows, flows to improve water temperature, and flows coordinated with fish hatchery operations.

The Shasta Reservoir reoperation strategy may consider fish passage above Shasta Dam into the colder water environments of the Upper Sacramento and McCloud rivers as a component. Fish passage above Shasta Dam is a core element of the Salmon Recovery Plan of the National Marine Fisheries Service (NMFS). The key issue is whether fish passage would allow more flexible operations of Shasta Dam that could facilitate the reoperation concepts under consideration.

Tradeoff Analysis

A tradeoff analysis is being performed as part of Phase 2 to help define the operations of the strategies. One of the purposes of the tradeoff analysis is to identify combinations of measures that will meet all three objectives of the study. While the ultimate objective of the SRS is to achieve simultaneous and system-wide net improvements in water supply, flood control, and ecosystem protection/restoration, there may be conflicts among the competing goals in the reoperation strategies. Understanding the tradeoffs among the competing goals will help in strategy formulation as the various measures and benefit types are pursued. For example, there may be tradeoffs within ecosystem goals between environmental flow improvements above the Delta and Delta outflow, and between different species (delta smelt and salmon) or even life stages of the same species (out-migration versus over-summer holding). There are also tradeoffs between goals such as water supply and flood hazard reduction.

A tradeoff analysis will facilitate consideration of the relative priority of the system reoperation objectives. For example, an ecosystem restoration action, if implemented in the existing system, will have an effect on water supply and perhaps other restoration objectives such as temperature management. This tradeoff analysis will provide a foundation for understanding the water system effects and will inform how measures can be ultimately combined into full system reoperation strategies. In addition, the tradeoff analysis will give potential system reoperation participants, such as managers, operators, regulators, and other stakeholders a better understanding of each measure under consideration.

Some of the key tradeoffs being evaluated as part of the Phase 2 includes:

- Flexibility in temperature management operations at Shasta Dam – the ability to change releases from Shasta Dam while complying with winter run temperature requirements is a key tradeoff for evaluating conjunctive management and environmental flows at Shasta Dam.
- Temperature and flow changes associated with higher spring releases and risks of warmer temperatures in the fall.
- North of Delta water supply reliability versus systemwide water supply.
- Effects of increased stream flows in the Feather River on water supply and storage in Lake Oroville.

Phase 2 was completed at the end of 2013. The strategy formulation and refinement process is documented in the Phase 2 report (California Department of Water Resources 2014).

Next Steps

Phase 3: Preliminary Assessments of Strategies

The study team will continue to refine the reoperation strategies to change operations in ways that may result in improved system performance in terms of additional water supply, flood hazard reduction, and ecosystem protection and restoration. Those reoperation strategies that survived through the vetting process will be evaluated for potential benefits at the regional and systemwide scale during Phase 3.

The purpose of Phase 3 is to evaluate, sort, and rank strategies based on their performance in meeting the goals and objectives of the study. The strategies will be examined for acceptability, completeness, effectiveness, and efficiency. Phase 3 will include:

- Defining baseline operations.
- Evaluating system reoperation strategies:
  - Identifying existing physical and operational constraints.
  - Identifying new or modified physical facilities needed for potential system reoperation strategies.
  - Conducting hydrologic and other modeling.
  - Quantifying benefits.
- Ranking reoperation strategies based on their performance.
- Selecting reoperation strategies to be carried forward into Phase 4 for more detailed analysis.

Phase 4: Reconnaissance-Level Assessments of Strategies

In Phase 4, the strategies evaluated in Phase 3 that met the objectives of the study will be carried forward into Phase 4 for more detailed evaluations. Phase 4 will include:

- Analyzing and assessing reoperation strategies.
- Evaluating benefits.

- Evaluating costs.
- Quantifying economic benefits.
- Developing conceptual designs for facilities modifications.
- Identifying institutional challenges.
- Documenting the findings.
- Recommending strategies for potential implementation.
- Identifying funding and key steps necessary for implementation.
- Making recommendations for next steps.
- Preparing a report.

The California Water Commission has developed a document titled *Description and Screening of Potential Tools and Methods to Quantify the Public Benefits of Water Storage Projects* that provides guidance on economic methods for quantifying public benefits of water storage projects. This document may be used to as a guidance to quantify the public benefits associated with the system reoperation strategies.

Climate Change

Climate change presents a significant challenge for California water management. Recent climate change studies project a broad range of potential effects, such as increases in air temperature, changes in the timing, amount, and form of precipitation, changes in runoff timing and volume, sea level rise, increased storm extremes, greater floods, and longer droughts.

While there is much uncertainty about how climate change will affect the overall amount of precipitation in California, there is general agreement that climate change will affect both the timing and form of precipitation. Climate change studies indicate that more precipitation will fall in the form of rain instead of snow and that higher temperatures will cause earlier snowmelt. The results of these changes in precipitation form and timing will be a decrease in the overall snowpack storage, as well as earlier and greater runoff from both rainfall and earlier snowmelt.

Climate Change Adaptation

Most of California's major surface water reservoirs are managed for multiple benefits, but are primarily managed for water supply and flood protection. During the winter, when storms are common, flood protection takes priority and this drives reservoir operation decisions. For the rest of the year, when storms are uncommon, water supply, water quality, and ecosystem management drive reservoir operation decisions.

As runoff patterns shift to occurring earlier in the year, more and more runoff will arrive during the flood operations period. Much of this water will need to pass through the reservoirs to allow the reservoirs to maintain adequate flood protection space. By the time the flood protection season ends, much of the runoff will have already passed through the reservoirs and will not be available in storage for use later in the year, which is during peak water demand periods.

In addition to changes in precipitation timing and form as a result of climate change, studies indicate that sea levels may rise by as much as 55 inches at the Golden Gate Bridge by 2100. Sea level rise would increase salinity in the Delta, requiring larger volumes of fresh water to control salinity for SWP, CVP, and other Delta water user operations. Delta salinity requirements are one of the primary constraints guiding the operation of the SWP and CVP systems.

System reoperation measures that primarily use existing storage infrastructure and conveyance systems, such as conjunctive use of surface water and groundwater, could help reduce climate change impacts such as reduced snowpack, more precipitation in the form of rain, and early snow melt. For example, by moving water to groundwater banking sites in the fall, reservoir levels could be lowered further so that excess water during the winter and spring could be stored in the reservoirs. This early reservoir drawdown would increase flood storage capacity and therefore improve flood protection. In turn, the water stored in groundwater banking sites would help supplement summer water supplies and decrease the reliance on reduced snowpack runoff.

Large-scale system reoperation measures, such as conjunctive use of surface water and groundwater, provide opportunities to adapt operations to climate change with an efficient and consistent approach.

Climate Change Mitigation

Mitigation is accomplished by reducing or offsetting greenhouse gas (GHG) emissions to lessen contributions to climate change. System reoperations can lead to emission reductions or emission increases, depending on the goals of the reoperation and whether climate change is considered during planning. For example, reoperating systems in a way that maximizes hydroelectric power generation would allow water managers to produce clean, renewable energy, thus reducing the need for GHG-intensive energy produced from burning of fossil fuels. However, because climate change is expected to bring larger, more intense precipitation events, reoperating the systems to provide additional flood protection benefits through the early release of water may decrease water availability during the summer months when water and electricity demands are highest, which could result in water pumping, water imports, and therefore increase the purchase of GHG-intensive energy sources. Reoperating systems that keep GHG emissions to the minimum of what is necessary to operate would be the best way to meet the needs of all parties while mitigating for climate change.

Major Implementation Issues

Physical Constraints

The capacity of existing infrastructure, such as storage and conveyance, could limit system reoperation opportunities to make water transfers, conduct conjunctive water management, and refine flood operations. Future studies should focus on eliminating infrastructure constraints in order to add flexibility to systems.

Institutional Constraints

Although there are numerous institutional arrangements that help water resource projects function together as a system, these same institutional arrangements present some very inflexible constraints that make it difficult and time-consuming to consider the reoperation potential of an entire system. Some of the relevant institutional constraints and the challenges they present are listed below.

- California's priority system for surface water rights, including area-of-origin water rights, presents complications for large-scale changes.
- Contractual obligations for water deliveries largely constrain the operations of many projects.
- Flood rule curves mandate the reservation of flood control space during the flood season. Changing rule curves would require congressional approval, which is a difficult and time-consuming process.
- Coordinated operating agreements already govern the operation of multiple projects (e.g., the agreement that governs SWP and CVP operations).
- Changes in federal project purposes require congressional approval.

Integrating Water Resource Management

California water resources management involves many tiers and players. Facilities are operated for local, regional, or nearly statewide beneficial uses. Implementing large-scale system reoperation would involve a combination of regulatory actions by local, regional, State, and federal agencies.

Planning, Design, and Implementation Costs

As mentioned earlier in this chapter, significant up-front and ongoing costs can be involved with system reoperation, as with the planning, design, and implementation of any large-scale infrastructure project.

Up-front planning and design costs might include such items as data collection, hydrologic and hydraulic model development, decision-support systems development, and environmental documentation necessary just to evaluate the benefits and impacts of proposed reoperation strategies through the feasibility study level. Tangible implementation costs would be associated with the actual removal, modification, or construction of any infrastructure.

Water management agencies might have difficulty raising needed funds for feasibility-level studies and implementation due to existing contracts or regulations that prohibit them from increasing water or energy rates. As with implementing any large-scale project, selling the project costs to those directly in line to receive benefits is a foregone necessity.

Recommendations

The following recommendations can help facilitate reoperation to meet water supply reliability, flood management, hydropower, water quality, ecosystem, and other objectives better.

1. State, federal, regional, and local agencies should collaborate on large-scale system reoperation studies to pool resources and share benefits.

2. The State and federal water operators should encourage and expand the use of forecast-based and forecast-coordinated reservoir operations.

3. The State should take the lead to establish a baseline hydrology applicable to large-scale system reoperations modeling.

4. The State should fund reoperation studies of smaller regional water purveyors through the Integrated Regional Water Management Grant Program.

5. The State should take the lead and develop an integrated water resources analytical tool to support regional and statewide system reoperation analysis that balances water supply, flood protection, water quality, and ecosystem needs. This tool would make the State a leader in large-scale integrated water management. Many local/regional agencies have their own tools for evaluating their local/regional systems. The State should support improvements to the local/regional tools and integrate them with the statewide tool.

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